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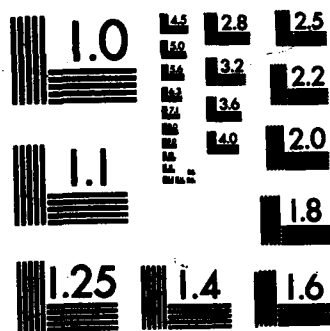
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RESEARCH, DESIGN AND DEVELOPMENT STUDY
TO MEASURE ATMOSPHERIC OPTICAL TURBULENCE

Robert S. Hills

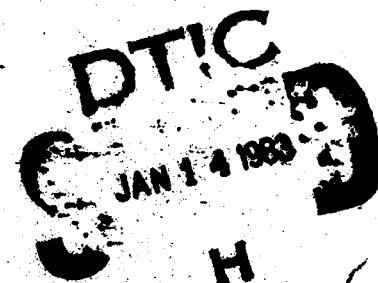
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765 Concord Avenue
Cambridge, Massachusetts 02138

November 15, 1982

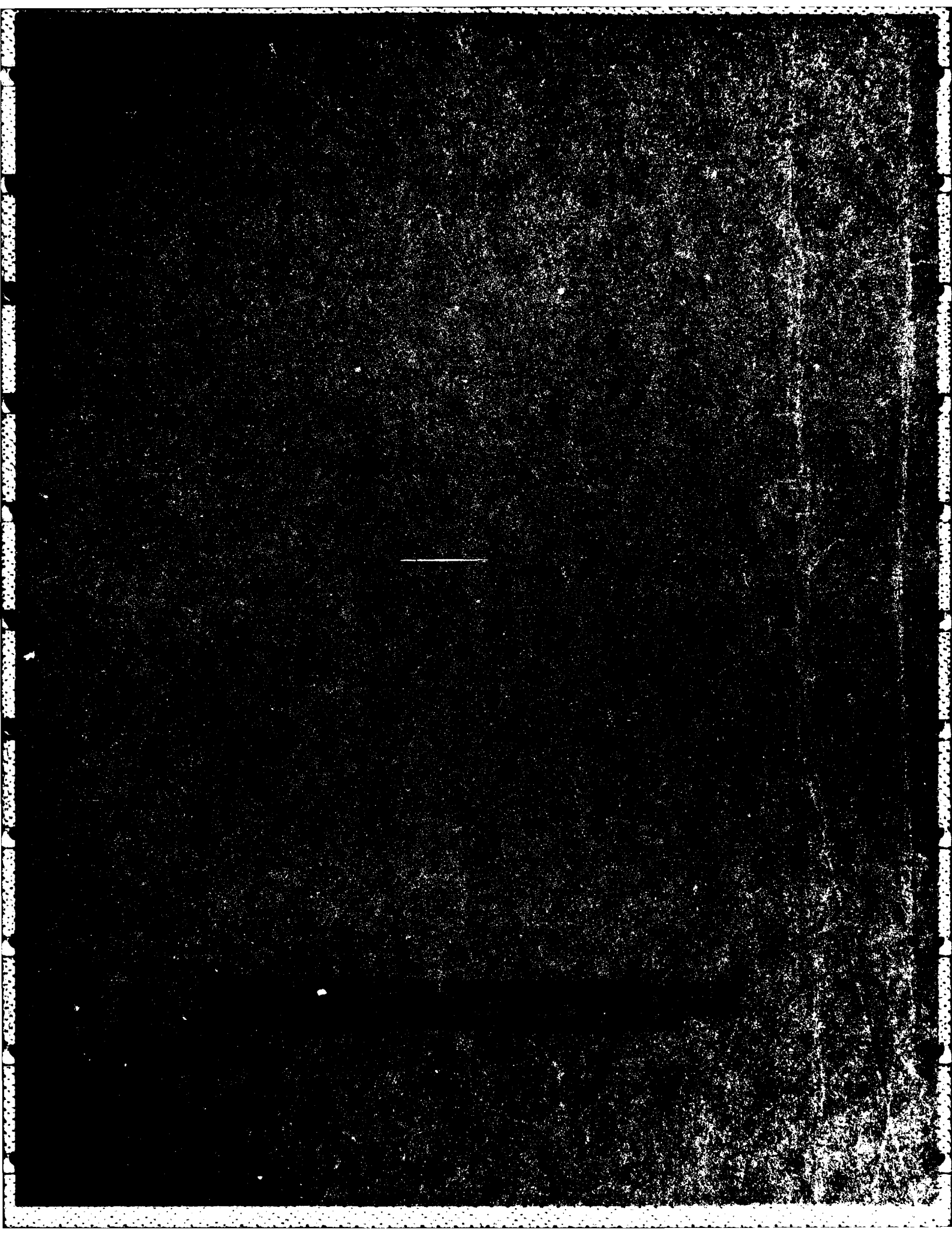
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AIR FORCE GEOPHYSICS LABORATORY
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → This report describes work performed in support of the AFGL program to study atmospheric turbulence and obtain the Atmospheric Optical Structure Constant, C_N^2 . C SUB N SAVED Data is obtained from a thermosonde unit and a radiosonde unit carried aloft by small weather balloons. Improvements in the thermosonde unit and modifications to the radiosonde unit are described. ←		

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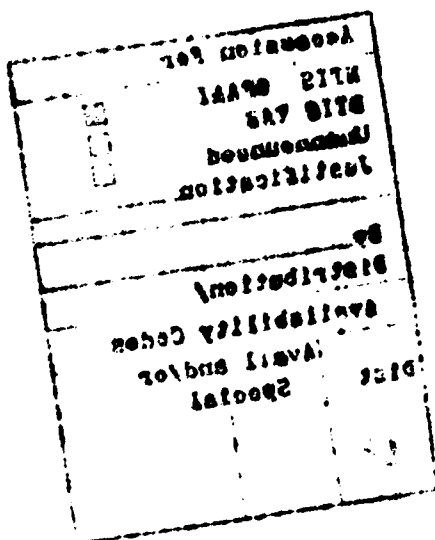


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1. INTRODUCTION

This report covers work performed by TRI-CON ASSOCIATES, INC. in support of the AFGL program to study atmospheric turbulence.

Data collected by a thermosonde and a radiosonde carried aloft by small weather balloons will be correlated with that from other instruments such as radar and scintillometers to obtain the atmospheric optical structure constant C_N^2 .

Both the thermosonde and radiosonde units, which already existed, were modified; the thermosonde to increase its sensitivity to small temperature changes and the radiosonde to enable it to also commutate the thermosonde outputs as well as its own data on pressure, temperature, and relative humidity. A diagram of the complete system is given in Figure 1 (D-2025).

Several sub-projects were undertaken and completed. These included design and construction of calibration test equipment, design of a sun sensor, design and construction of a telemetry signal conditioner, check-out of newly purchased thermosonde boards and radiosondes, design and construction of a downrigger system and purchase of a tape cassette transport for recording data on a balloon project and providing field service both locally and in Hawaii for the launch of thermosondes and radiosondes on small weather balloons. These projects are described below in more detail.

2. THERMOSONDES

A number of resistance changes were made in the thermosonde circuit to increase the overall signal gain. Refer to the schematic shown in Figure 2 (D-1078).

a. R_5 is changed from 14.3K to 2.7K resulting in a higher bridge current of 108 μ a RMS per branch. This higher current will give a higher ΔV per ΔR and results in an increase in gain without a corresponding increase in noise. The current cannot be increased further without heating of the probe itself resulting in an unwanted resistance change.

b. R_{63} is changed from 71 ohm to 20 ohm and R_{64} is changed from 30K ohm to 60K ohm. The gain of the pre-amp is increased from a nominal 350 to 1000.

c. R_{32} and R_{33} are changed from 40.2K ohm to 124K ohm to increase the gain of U_3 by a factor of three.

d. R_{71} is changed from 100K ohm to 200K ohm. This results in a high gain to low gain ratio of five instead of ten.

e. R_{89} and R_{96} are changed from fixed resistors to 10K ohm potentiometers in series with 30K resistors to allow for output current adjustment with zero signal input. This is used to set the minimum frequency of the MET data oscillator when the thermosonde is being sampled.

f. R_{87} and R_{93} are changed from 75K ohm to 56K ohm. These resistors set the $\Delta f / \Delta R$ probe of the system because they determine the modulating current.

A layout of the revised thermosonde board is given in Figure 3 (D-1079). This information was part of a bid package resulting in procurement of a set of 40 thermosondes from ZERCOM Corp. Most of these thermosondes were tested at TRI-CON and were returned with calibration curves to AFGL. A connector wiring diagram is given in Figure 4 (C-2077), the card enclosure drawing in Figure 5 (D-2026), and overall wiring in Figure 6 (D-2019).

Other thermosonde boards which had been made at AFGL and exhibited problems when tested at AFGL were corrected at TRI-CON. In almost all cases the problems stemmed from installation of wrong value components and bad solder joints.

The current output of the voltage to current converter with no input signal to the thermosonde had been set during calibration to about 30 Hz. This was changed to 100 Hz on all the ZERCOM boards and new AFGL boards. This change was made to satisfy the requirements of the computer group doing the data reduction. It also should result in better stability of the setting since the voltage to current converter transistors will not be operating as close to cutoff.

The test procedure used for check-out and calibration of the thermosonde board is given at the end of this report. It is used with a test set which contains a 20 Hz oscillator to insert calibrated probe shunting resistors to simulate temperature changes. The value and effect of the resistors is given in Tables 1 and 2.

3. FIELD AND PRODUCTION TEST CONSOLE

Several models of the test set were made. All contained the oscillator and switched resistors. Two more sophisticated test consoles were made for use both with the thermosonde board and for use in the field to clear up the received telemetry signal and to convert frequency to voltage for quick look, real time data observation. A schematic of this test console is given in Figure 7 (D-2096).

The telemetry data conditioner was designed to restore the pulse train wave shape after the data was decommutated at the ground station, and before it was stored on magnetic tape. The magnetic tape serves as the data storage input to a computer so that fluctuations in voltage levels and base line deviations would sometimes lead to errors in the data reduction. The base line deviations, which were low frequency, are eliminated by the high pass filter comprised of C_1 and R_1 , R_2 . U_2 serves as a threshold detector which will distinguish the data pulse from the accompanying noise. The threshold level is adjusted with R_3 and is normally set at 0.5 volts.

FIELD AND PRODUCTION TEST CONSOLE #1
SIMULATED PROBE RESISTORS = 27.4 OHM
TEMPERATURE COEFFICIENT .00375/°C

RESISTOR	OHMS	ΔR
R ₁	1.4x10 ⁶	.000536
R ₂	720x10 ³	.001043
R ₃	360x10 ³	.002085
R ₃ /R ₂	240.0x10 ³	.003128
R ₄	180.3x10 ³	.004163
R ₄ /R ₂	144.2x10 ³	.005205
R ₅	120.1x10 ³	.006250
R ₅ /R ₂	102.9x10 ³	.007294
R ₆	90.0x10 ³	.008339
R ₇	72.0x10 ³	.01042
R ₈	48.0x10 ³	.01563
R ₉	36.0x10 ³	.02084
R ₁₀	29.0x10 ³	.02557
R ₁₁	24.1x10 ³	.03112
R ₁₂	20.6x10 ³	.03640
R ₁₂ /R ₄ /R ₂	18.00x10 ³	.04164
R ₁₂ /R ₇	16.02x10 ³	.04678
R ₁₂ /R ₈	14.4x10 ³	.05204

TABLE 1

FIELD AND PRODUCTION TEST CONSOLE #2
SIMULATED PROBE RESISTORS = 27.4 OHM
TEMPERATURE COEFFICIENT .00375/°C

RESISTOR	OHMS	ΔR
R ₁	1.4x10 ⁶	.000536
R ₂	720x10 ³	.001043
R ₃	361x10 ³	.002080
R ₃ /R ₂	240x10 ³	.003128
R ₄	180.4x10 ³	.004161
R ₄ /R ₂	144.0x10 ³	.005213
R ₅	120.0x10 ³	.006255
R ₅ /R ₂	103.0x10 ³	.007287
R ₆	90.7x10 ³	.008275
R ₇	72.0x10 ³	.01042
R ₈	48.0x10 ³	.01563
R ₉	36.0x10 ³	.02084
R ₁₀	29.1x10 ³	.02586
R ₁₁	24.2x10 ³	.03099
R ₁₂	20.7x10 ³	.03622
R ₁₂ /R ₄ /R ₂	18.1x10 ³	.04141
R ₁₂ /R ₇	16.1x10 ³	.04655
R ₁₂ /R ₈	14.4x10 ³	.05204

TABLE 2

The output of the comparator triggers U3, which is a CMOS integrated circuit monostable multivibrator. The output pulse width of the multivibrator is determined by C_2 , R_7 and this was set for about 200 microseconds.

The operational amplifier U4 converts the 15 volt 200 microsecond multivibrator pulse to a pulse of 5 volts amplitude swinging between levels of -2.5 volts and +2.5 volts. This is the input signal required by the tape recorder.

The console contains a frequency to voltage converter. The temperature changes measured by the thermosonde result in a change of the rate of received telemetered pulse. The pulse rate is very difficult to interpret from direct observation especially since it is commutated for only one quarter of a second every two seconds. A Burr Brown frequency to voltage converter module is used to give a 0 to 5 volt output for a pulse rate input of 0 Hz to 1000 Hz.

4. RADIOSONDES

The addition of the thermosonde, with its high gain and low gain signal outputs, to the radiosonde system made it necessary to add two more segments to the existing four segment commutator. It was decided to actually add four more segments making the commutator into an eight segment unit. Initially, the VIZ Corporation units were modified by adding a small auxiliary commutator to the four segments contained in the standard VIZ radiosonde. This involved fabricating an auxiliary board with a commutator and rewiring part of the radiosonde. The work was performed at AFGL and proved to be time consuming and costly.

A decision was made to have VIZ modify their design for future units thus, saving the Government time and money during the integration of future C_N^2 payloads.

The requested modifications are:

a. Change the four segment commutator to eight segments with the following sequence:

1. Pressure
2. Temperature
3. Humidity
4. Reference (1000 Hz)
5. Auxiliary 1
6. Auxiliary 2
7. Auxiliary 3
8. Auxiliary 4

b. Jumper provisions with terminals to allow for super commutating pressure, temperature, etc. to any of the auxiliary channels.

c. Change the method of modulation for the data from AM to FM.

d. Provide a lock up or channel selection for each of the eight bits in the commutator.

e. Change the frequencies in the pressure mode to yield the following:

- | | |
|-----------|----------|
| 1. Space | - 500 Hz |
| 2. Green | - 600 Hz |
| 3. Blue | - 700 Hz |
| 4. Yellow | - 800 Hz |

f. Change the method of clocking the commutator counter

so that the clock amplitude is essentially that of V_{DD} . All COSMOS circuits should have the same V_{DD} to insure reliable operation.

Upon delivery of the 50 new VIZ rawinsondes it was realized that a modification had been made in the oscillator circuit which modulates the transmitter. The old circuit accepted currents set by either the resistances of the sensors or by the thermosonde output circuits. These currents set the pulsing rate of the oscillator. However, the new circuit cannot accept external current and thus the thermosonde board high and low channel output currents cannot be used to set the frequency of the oscillator.

TRI-CON has suggested a modification to the circuit which permits the external thermosonde currents to control the oscillator. Simplified diagrams of the circuit as delivered by VIZ and also as modified by TRI-CON are shown in Figure's 8A and 8B. The operation is as follows: With the 3130 comparator output high, the + input is high and the capacitor C on the - input is charging positively through the 43.7K resistor and the selected sensor resistance from the 3130 output. When its voltage reaches the voltage on the + input the 3130 output flips to almost 0 volts. The + output becomes less positive and the capacitor discharges towards 0 volts through the same resistances. When the capacitor voltage reaches the same value as that on the + input the 3130 flips again and C starts to charge positively.

Auxiliary sensors can be added to the circuit of Figure 8A only as long as the sensors are isolated resistors. But external currents cannot be introduced.

In the circuit of Figure 8B the 4051 multiplexer input and output connections have been interchanged. Now a current introduced into a switched port will charge the capacitor and flip the state of the 3130. A diode is added as shown to discharge the capacitor and re-flip the 3130 so that the charging can start again. Thus the oscillator can be controlled by the thermosonde output currents.

The 12 volt power source for the original circuit which was derived from a 12 volt zener diode has been changed to 9 volts by changing the diode. This was necessary to allow the external current source (thermosonde outputs) to pump current into the circuit.

The new units also do not have the multiplex points for the high and low thermosonde signals brought out to a connector.

Temperature and relative humidity signals will be strapped to two empty segments so that the complete sequence is:

- Pressure
- Temperature
- Relative Humidity
- Reference

Thermosonde High Gain
Temperature
Relative Humidity
Thermosonde Low Gain

TRI-CON made the above modifications to all the VIZ units and added the missing cable and connector. The modified radiosonde schematic is shown in Figure 9 (C-3042). Fifteen of the radiosondes were shipped to Hawaii in October. As mentioned above these radiosondes were set-up for frequency modulation. The ground receiving station could demodulate only amplitude modulation. So these units were reworked in the field for the original amplitude modulation. More details are given in the field trip report included with this report.

5. TEMPERATURE TESTS

Temperature tests were conducted at AFGL to determine the operating temperature range of the thermosonde radiosonde payload. The balloon flight time and the exact temperature profile are difficult to reproduce, but, the performance of the instruments near the expected operating temperature can be evaluated.

Test leads were connected to measure the output of both RMS units, the reference zener, and the output of both level shifting amplifiers U14 A & B.

These output stages were monitored because any DC drift with

temperature in the preceeding circuits will be blocked by C_{27} and C_{29} . The temperature of the chamber and the thermosonde board are measured and recorded.

An examination of the chart (Table 3) on the following page shows that the instrument's performance is satisfactory, $\pm 5\%$ for temperatures down to -30°C . The R_2 signal input on both the high and low gain scales, shows a large error in the -30°C . column. This error is attributed to the voltage to current converter U15, because the reference frequency and the RMS outputs do not have an error of the same magnitude.

A monitor of the signal at test point "D" using an external RMS meter shows the $\pm 5\%$ fluctuation is not a linear function of temperature. For example, the gain increases from room temperature to -7.8°C and then decreases from -7.8°C to -30°C . This gain vs temperature is probably due to a combination of components, with the demodulator U2 and the sine wave oscillator amplitude possible sources of drift.

6. SUN SENSOR

Some early flights of the thermosonde and gondola had shown large periodic offsets in the data which may have been caused by a temperature differential due to the sun on the probes. A sun sensor consisting of a phototransistor on each probe boom close to the probe was to be used to tell

t / Board T Chamber	Room Temp	+5°C/-28°C	-7.8°/-36°C	-21°/-45°C	-30°/-52°C
Low Gain RMS (Volts)	.004	.03	.03	.04	.04
High Gain RMS (Volts)	.144	.17	.18	.19	.19
U14 Pin 12 (Volts)	11.53	11.55	11.55	11.54	11.54
U14 Pin 10 (Volts)	11.56	11.58	11.57	11.59	11.61
Zener Voltage	11.57	11.59	11.58	11.59	11.58
Reference Frequency(PPS) 982			968	972	975
High Gain No Input(PPS) 29	Counts ¹ RMS ²	Counts RMS	Counts RMS	Counts RMS	Counts RMS
R ₂	78 .406	82 .42	82 .42	70 .40	118 .39
R ₄	298 1.35	299 1.35	314 1.42	280 1.30	285 1.25
R ₆	600 2.65	599 2.68	633 2.8	574 2.55	549 2.45
Low Gain No Input(PPS) 34	Counts ¹ RMS ²	Counts RMS	Counts RMS	Counts RMS	Counts RMS
R ₂	243 .976	242 .97	253 1.02	230 .92	330 .87
R ₄	393 1.64	390 1.62	412 1.71	373 1.54	355 1.46
R ₆	560 2.38	555 2.34	586 2.48	531 2.22	507 2.12
External RMS On					
Test Point "D" With (Volts) 1.44		1.44	1.51	1.37	1.31
R ₆ (Low) As An Input					

THERMOSONDE TEST DATA

TABLE 3

NOTES:

1. Counts = radiosonde frequency outputs
2. RMS = outputs of thermosonde RMS units

when each probe was being shadowed (transistor off). The output of the sensor was to be used to modulate the MET data oscillator to four different frequencies as follows:

Both sensors shadowed	≈ 200 PPS
A in sun, B shadowed	≈ 360 PPS
A shadowed, B in sun	≈ 450 PPS
Both sensors in sun	≈ 490 PPS

A schematic is shown in Figure 10 (A-2041). The sensor was never actually flown since in current flights the thermosonde is suspended far below a small weather balloon and there is no chance of shadowing.

7. THERMOSONDE SYSTEM WITH DOWNRIGGER AND RECORDER

Work was begun on a thermosonde system which will be lowered and raised over a vertical distance of 200 to 300 feet below the balloon while collecting data. The data, including that for pressure and temperature, will be recorded directly on a magnetic cassette by means of a tape transport which is part of the payload.

- 7a. The downrigger unit, consisting of a motor driven reel containing 200 feet of stainless steel line, was received from the vendor. The motor operates from 12 volts and direction of rotation depends upon polarity. A worm gear on the motor shaft drives the reel through an adjustable clutch so line is wound or unwound at about one foot per second. The motor pulls 2 to 4 amperes depending on the load and its torque is sufficient to spool up a 10 pound

weight. The grease was removed from the gears and replaced with a very small amount of special low temperature grease suitable for use on satellites. (Batco X-9929, Battenfeld Grease & Oil Corp., North Tonawanda, N. Y.).

The existing reel revolution counter was removed and replaced by a 40 to 1 gear reducer. (Berg, Inc. RX11-8). The gear reducer output is connected to a 10 turn 5K ohm potentiometer. Each revolution of the reel pays out about 0.75 feet of line so about 265 revolutions of the reel are needed to pay out 200 feet of line. With 9 volts impressed across the pot the pot arm voltage indicates the length of line deployed and also the voltage is used to automatically reverse the direction of rotation of the reel when the line has been unwound. This is done by electronic circuits which sense the pot voltage and operate the motor power polarity reversing relay.

A schematic of the electronics is given in Figure 11 (D-3050). The schematic also shows the use of the single command to start, stop, and return the reel to the stored position. Operation of the command circuit is as follows: Before a command is received, the multi (4047) is not oscillating and the counter (4520) is held in the reset to all zeros state and decoder (4555) is disabled so that all coils in the on/off control latching relay K_3 are deenergized and also all coils in the rewind/store relay K_4 are deenergized. The execution of the command will immediately enable the

binary decoder in the A=0, B=0 state and energize the "off" coil of K₃ through the drive transistor connected to Pin 4 of the decoder. The command also allows the astable multivibrator to oscillate and after 4 cycles (about 2 seconds) the counter outputs will be decoded (A=1, B=0) to drop out the "off" coil and energize the "on" coil. If the command is executed for more than 8 seconds the "on" coil drops out and the "rewind/store" coil of K₄ is energized.

The electronics and the motor are both operated from a 12 volt, 4 ampere hour nicad battery (10 Gould "D" size cells). The electronics and battery are mounted in an insulated aluminum box.

The system was operated in a horizontal configuration on the sidewalk adjacent to F Building at AFGL. The commands controlled the system correctly using a local command button on the electronics box. The line unreeled until the reel reversed at a pot voltage of 3.9 volts and 185 feet deployed. The reel reversed again at 0.55 volts and 15 feet deployed. The rewind command rewound the reel to 5 feet at 0.25 volts on the pot and then stopped the motor. The system was then given to AFGL personnel for shipment to White Sands Missile Range and installation on the gondola for the October balloon flight. The downrigger test was completely successful.

- 7b. The fixed speed (1 7/8 inches/second) Phi-Deck Cassette transport ordered from Triple I, Inc. was received at the end of September. Operating and control instructions for it seem adequate to permit AFGL to use it for its intended purpose of recording data from a thermosonde with the units suspended at the end of the downrigger line. The cassette transport is a 2 track, 2 channel record/play system with

all electronics including motion control of the transport.

The deck motion is controlled by four basic commands; rewind, fast forward, run, and stop. These functions are initiated by a momentary logic high applied to the appropriate pins of the remote control connector. A complete explanation is given in the literature which is with the unit.

The deck can handle a standard C-120 cassette which will give 60 minutes of recording in one direction. A micro-switch which is released at the first deployment of the downrigger could be used to start the transport and it would run to the end of the tape and shut off. Details of the operation will be determined at a later date.

8. SYSTEM IMPROVEMENTS

The sensitivity of the present thermosonde is such that the smallest temperature difference that can be reliably measured is about 0.002°C rms. Any further increase of sensitivity would result in an increase of noise and instability beyond the allowable limit. So it would seem that the input circuits cannot be improved.

However, the output voltage to current converter does contribute to output signal drift. This circuit is necessary only because the VIZ radiosonde requires a current input. If the radiosonde could accept an input voltage instead of

an input current the converter problem would be eliminated.

The data reduction procedure requires that the frequency of the pulse rate, representing the temperature difference between the two probes, be measured and digitized for computer processing. This is a complicated and expensive process since the thermosonde data is sampled by the radiosonde for only 0.25 seconds every 2 seconds. If the data from the thermosonde were already in digital form representing pulse rate, the expensive first step could be eliminated and the received data fed directly into the computer for analysis.

APPENDIX I

Quality Control & Test

Each individual board will be inspected visually before power is applied to the circuit. The visual inspection will include:

- (a) Solder Connections
- (b) Component Orientation for Semiconductors and polarized capacitors
- (c) Component Values

TEST PROCEDURE FOR THE THERMOSONDE BOARD

EQUIPMENT: Power Supplies ± 18 volts

Digital Voltmeter

Oscilloscope

RMS Meter

Calibration Test Box

Micro-ammeter

Test Oscillator

Frequency Counter

- STEP 1 Connect $\pm 18V$ power supplies to the thermosonde board using connectors J_3 and J_{13} .
- STEP 2 Connect the calibration test box to the thermosonde board using J_{12} . All switches "OFF" (down) except dummy probe switch which should be "ON".
- STEP 3 Turn on the power supplies and observe the current being drawn, it should be less than 100 ma from each supply.
- STEP 4 Using the digital voltmeter measure the outputs of the voltage regulator V_g . The output voltages should be:
- + 15 volts + or - 0.5 volts (Pin 2)
 - 15 volts + or - 0.5 volts (Pin 7)
- STEP 5 Connect the oscilloscope to Pin 10 of U1 and observe a 3 KHz sinewave.

- STEP 6 Connect second channel of oscilloscope to Pin 12 of U1 and observe 3 KHz squarewave. Adjust scope to display both channels simultaneously (channel adjust switch on CHOP and scope sweep synchronized externally from the squarewave signal). Adjust R₈ so that the sinewaves and squarewaves are exactly out of phase. The amplitude of the sinewave signal should be about 6 volts peak to peak. Remove oscilloscope leads.
- STEP 7 Connect a clip lead across C35 and adjust R₄₈ and R₄₃ so that the outputs of U5A (Pin 10) and U5B (Pin 12) are greater than + seven volts as measured with the digital voltmeter.
- STEP 8 Using a 1/1 probe and amplitude setting of 50 MV/Div. attach the scope probe to test point C. Adjust R₆₀ until the three kilohertz sinewave is at a null point. Insure absence of high frequency (>3 KHz) at this point.
- STEP 9 Move the scope probe to test point "D" and adjust R₂₄ until the peaks of the demodulated three kilohertz ripple are even.
- STEP 10 Connect the DVM to Pin 1 of U10. The voltage level at this point should be less than 10 MVDC. Repeat for Pin 7 of U10.
- STEP 11 Connect the digital voltmeter to the Cathode of CR₁ and the oscilloscope to test point "C". Adjust R₄₈ while observing the digital voltmeter and the oscilloscope. As Q₁ starts to turn on, the three kilohertz wave at test point "C" will start to increase. At this point observe the voltage at the cathode of CR₁ and back off R₄₈ until the voltage at CR₁ is 0.5 volts more positive than the start of turn on. Move the digital voltmeter to the cathode of CR₂ and adjust R₄₃ in the same manner.

- STEP 12 Add 47K ohm resistors from the high gain and low gain outputs to ground. Remove the short from C35. Turn on the oscillator in the Test Box. With resistor switches R_1 through R_{12} open, adjust R_{96} on the Thermo-sonde board to produce 0.22 volts DC across the high gain 47K ohm resistor (Use digital voltmeter). Turn on switch R_2 and adjust R_{62} for 0.4 volts across the 47K ohm resistor. Open switch R_2 . Sequentially close and open switches R_1 through R_7 and record voltages on the 47K ohm high channel resistor.
- STEP 13 With resistor switches R_1 through R_{12} open, adjust R_{89} to produce 0.22 volts across the low gain channel 47K ohm resistor. Sequentially close and open resistor switches R_7 through R_{12} , and also R_7 and R_{11} together and R_8 and R_{11} together and record the voltages on the low gain channel 47K ohm resistor.
- STEP 14 Check the outputs of the RMS modules (Pin 8 of U11 and U12) using digital voltmeter. The high gain RMS (U12) may have 0.1 to 0.3 volts output because of existing noise level. The low gain RMS output should be less than .1 volts.

APPENDIX 2

Trip Report on Balloon Launches in Hawaii

A series of thermosonde - Radiosonde Payloads were launched from the Mount Haleakala Observatory site on Maui, Hawaii during the month of August 1982.

The thermosonde units were calibrated at AFGL prior to being shipped to Hawaii, but, field modifications were made to the radiosondes to change the transmitter modulation from FM to AM.

The PC board layout which is inside the antenna cone of the VIZ 1680 MHz transmitter is the same for both AM and FM modulation. In the AM mode a transistor in series with the emitter of the oscillator transistor is turned on and off to produce 100% AM modulation. In the FM mode a signal is fed into the base of the oscillator transistor by way of a series R - C circuit.

Conversion from FM to AM requires two transistors, (Darlington connection) three resistors and a capacitor. The components were purchased with the anticipation that the change would be made at the launch site.

After unpacking the equipment a schematic of the GMD receiver was obtained from the Air Force crew which were launching weather balloons.

Interfacing of the low voltage semiconductor circuits to the high voltage vacuum tube circuits in the receiver was accomplished by way of a cathode follower whose positive voltage excursion was clamped at plus eleven volts.

In order to minimize the AM modification time, a review of the transmitter circuit design resulted in a possible different approach.

By changing the R - C network which was used for FM modulation and increasing the drive signal it was possible to AM modulate the transmitter without adding the resistors and transistors to complete VIZ's circuit.

In the FM design the modulating signal was derived from the center tap of a 50K ohm potentiometer which was driven by the output of U5C a CMOS gate (VIZ Drawing 01-149913).

For AM modulation the signal was derived from U5C, which was a full scale negative going nine volt pulse. The negative pulse was chosen to turn the transmitter off in the same manner as the VIZ modulating transistors.

The 6800 ohm resistor located on the transmitter board was reduced to about 900 ohm to increase the modulating signal strength.

Interference

The integration of the thermosonde to the radiosonde proved

to be a bigger problem than anticipated because of the pickup or interference when the transmitter was on.

It was known from previous laboratory tests that certain instruments such as the Hewlett Packard Counter, the Brush recorder and soldering irons in close proximity to thermosonde would cause small offsets in the output.

The sensitivity of the thermosonde is in the sub-micro volt range in the bandwidth of from about 0.5 hertz to about 3 KHz. A continuous wave FM modulated signal could possibly cause a slight offset, but, it would not have as great an effect as a carrier switched on and off with frequencies within the thermosonde bandwidth.

To reduce the undesirable offset, a number of contributing parameters were investigated.

(a) A shield was fabricated out of aluminum foil and grounded internally with a short piece of buss wire.

(b) The auxiliary test leads used for calibration were removed to eliminate their acting as antenna. During calibration these leads are terminated near the "front end" of most sensitive part of the thermosonde circuit.

(c) In the original test setup both the thermosonde and radiosonde were powered by ± 18 volt power supplies. To eliminate conductive interference during integration a battery pack was purchased to power the transmitter and the power supplies were used exclusively for the thermosonde.

It should also be mentioned that the observatory site had numerous instruments which could add to the interference problem. The site was a highly classified area and little or no information was available as to when local equipment was being used.

Flight Performance

The overall performance of the thermosonde - radiosonde instrument package for this series of flight can be considered very good. On some of the flights a loss of signal occurred, but, this could be explained by the flight trajectory which had the mountain in between the airborne transmitter and the receiving antenna.

A new design of the VIZ oscillator - commutator board which now has the circuits referenced to ground instead of a floating +3 volts may allow for a redesign of the thermosonde output signal.

It would be desirable to eliminate the voltage to current conversion stage which was necessary when interfacing with the original floating circuit.

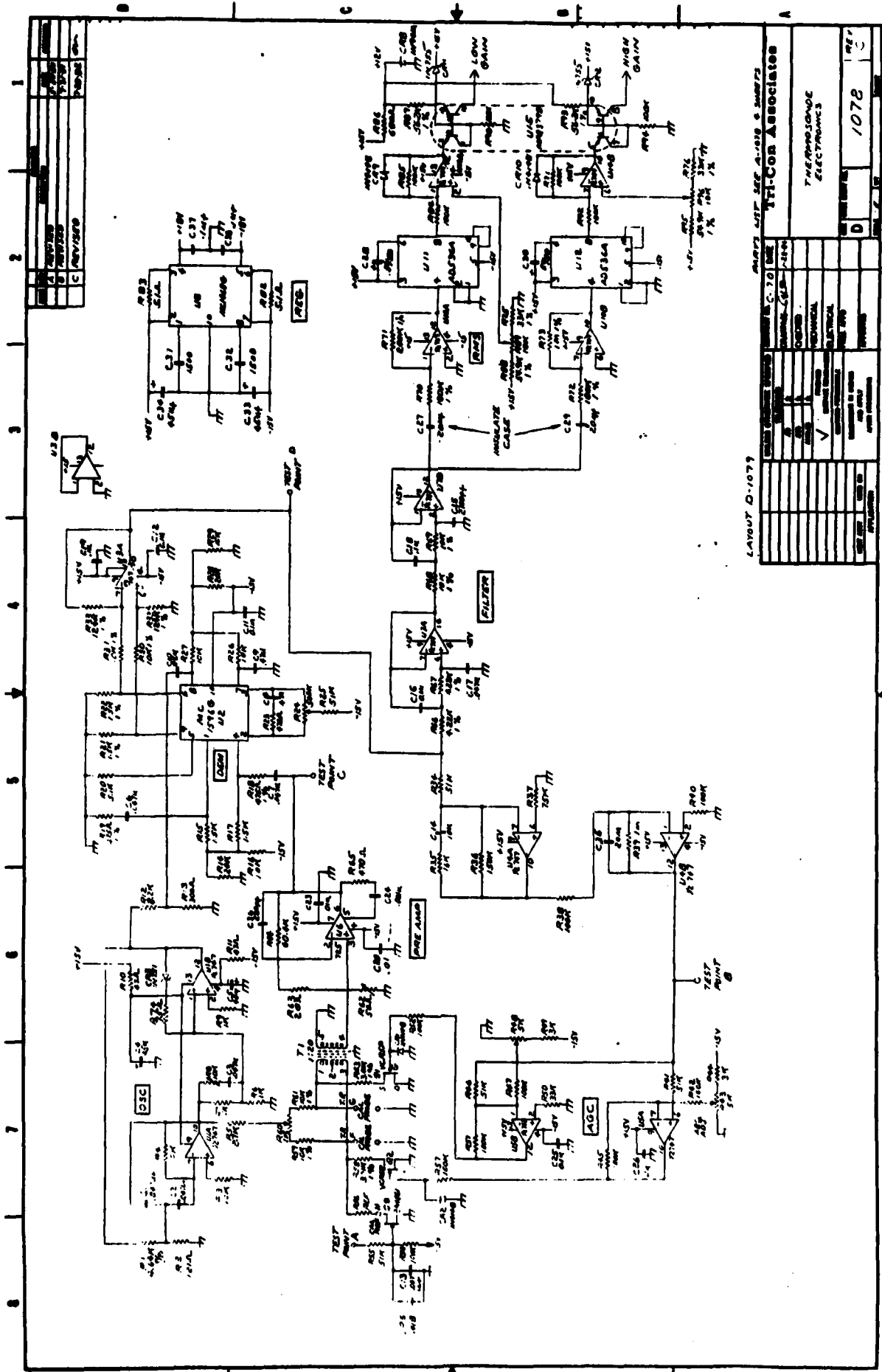
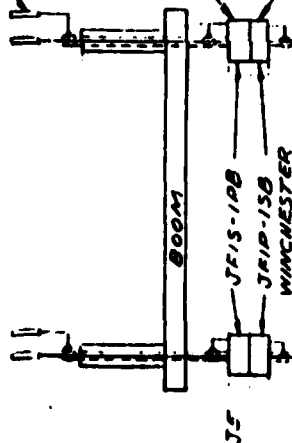


FIGURE 2



ZONE	DATE	DESCRIPTION	REVISIONS
1	7-20-61	REVISED CONNECTER INFO	1
2	7-20-61	REVISED JS9J6	2

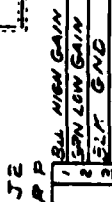
WIRE PINS (4 RED) TO FIT IN ABOVE CONTACTS



SHIELD TO J6 FEMALE TYP JS9J6

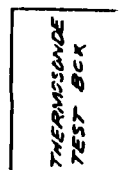
SHIELD TO RAYCHEM MALE 1 COND SHIELD 26AWG 49A-1111-28-9-9

MOLEX
J2, PC3-06-2054 PIN 02-06-2132
J2, PC3-06-1055 PIN 02-06-1132

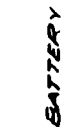


MOLEX

J2, PC3-06-1041 PIN 02-06-1132
J2, PC3-06-2041 PIN 02-06-2132



THERMOCOUPLE



+18V BATTERY



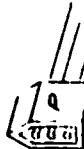
-18V BATTERY

RECEIVER



FEMALE PINS

PLUG



MALE PINS

ASSEMBLY D-2026
LAYOUT - D-1679
SCHEMATIC - D-1676

ALL WIRE #20 UNLESS NOTED

UNLESS OTHERWISE SPECIFIED		CONTRACT NO. 6-61	DATE
TOLERANCES		DRAWING	SCALE 1/8"
AS	±	6-61	1/8"
ANGLES	±	CHECKED	
FINISHED SURFACE DIMENSIONS		MECHANICAL	
CENTERS PERMISSIBLE		ELECTRICAL	
DIMENSIONS IN INCHES		PROJ. APPD	
AND APPLY AFTER PROCESSING		APPROVED	
NOT SET	USED ON		
APPLICATION			

Tri-Con Associates	
WIRING DIAGRAM THERMOCOUPLE	
REV	2077
REV	5

FIGURE 4

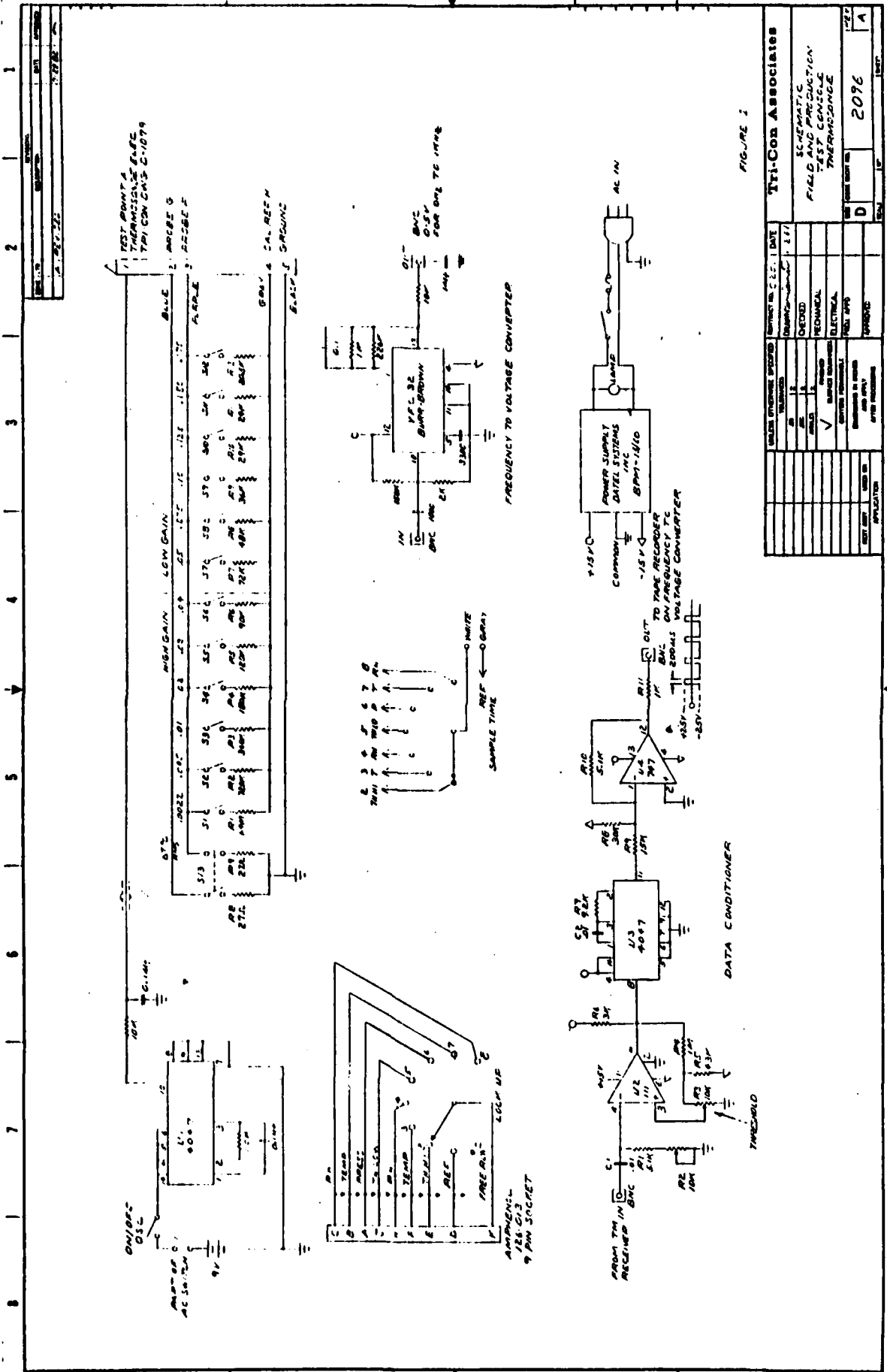


FIGURE 7

Tri-Con Associates		DATE	
DESIGNED BY	DATE	DESIGNED BY	DATE
TESTED BY	DATE	TESTED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
SCHEMATIC		FIELD AND PRODUCTION	
TEST CONSOLE		THERMOCOUPLE	
2096		A	

FIGURE 7

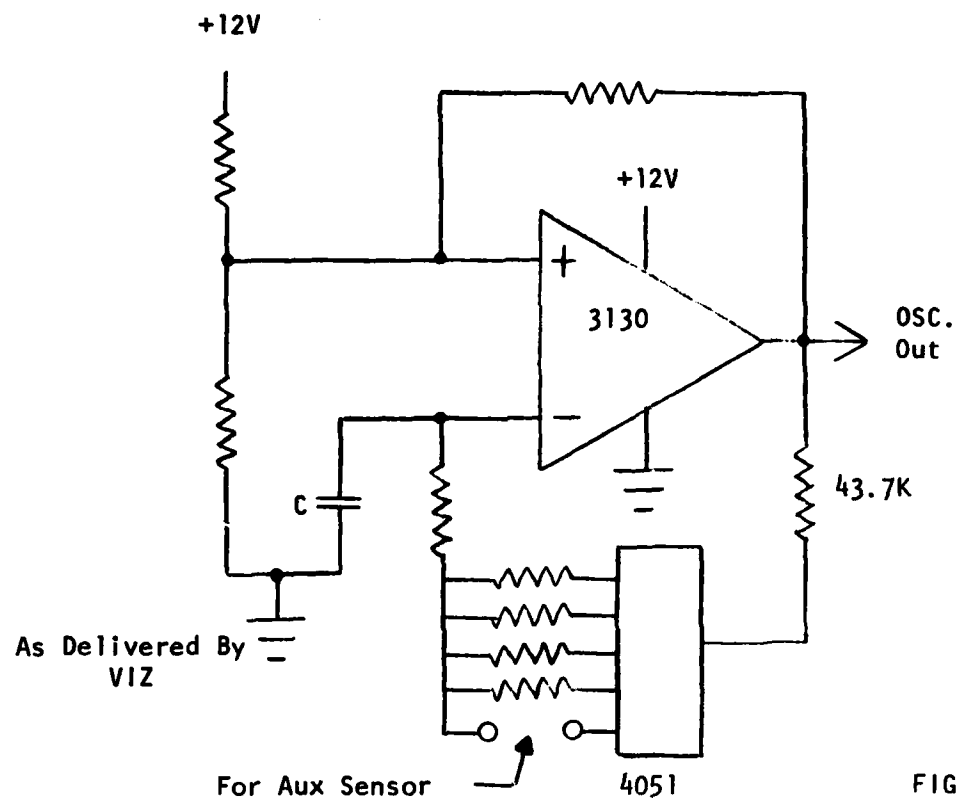


FIGURE 8A

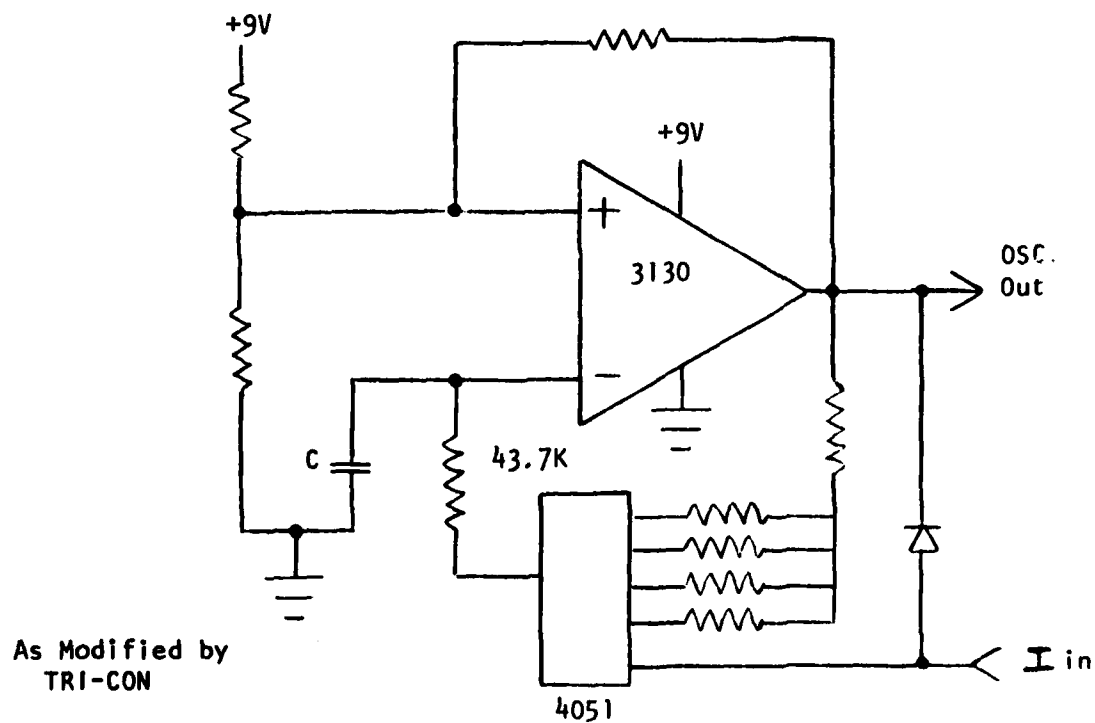
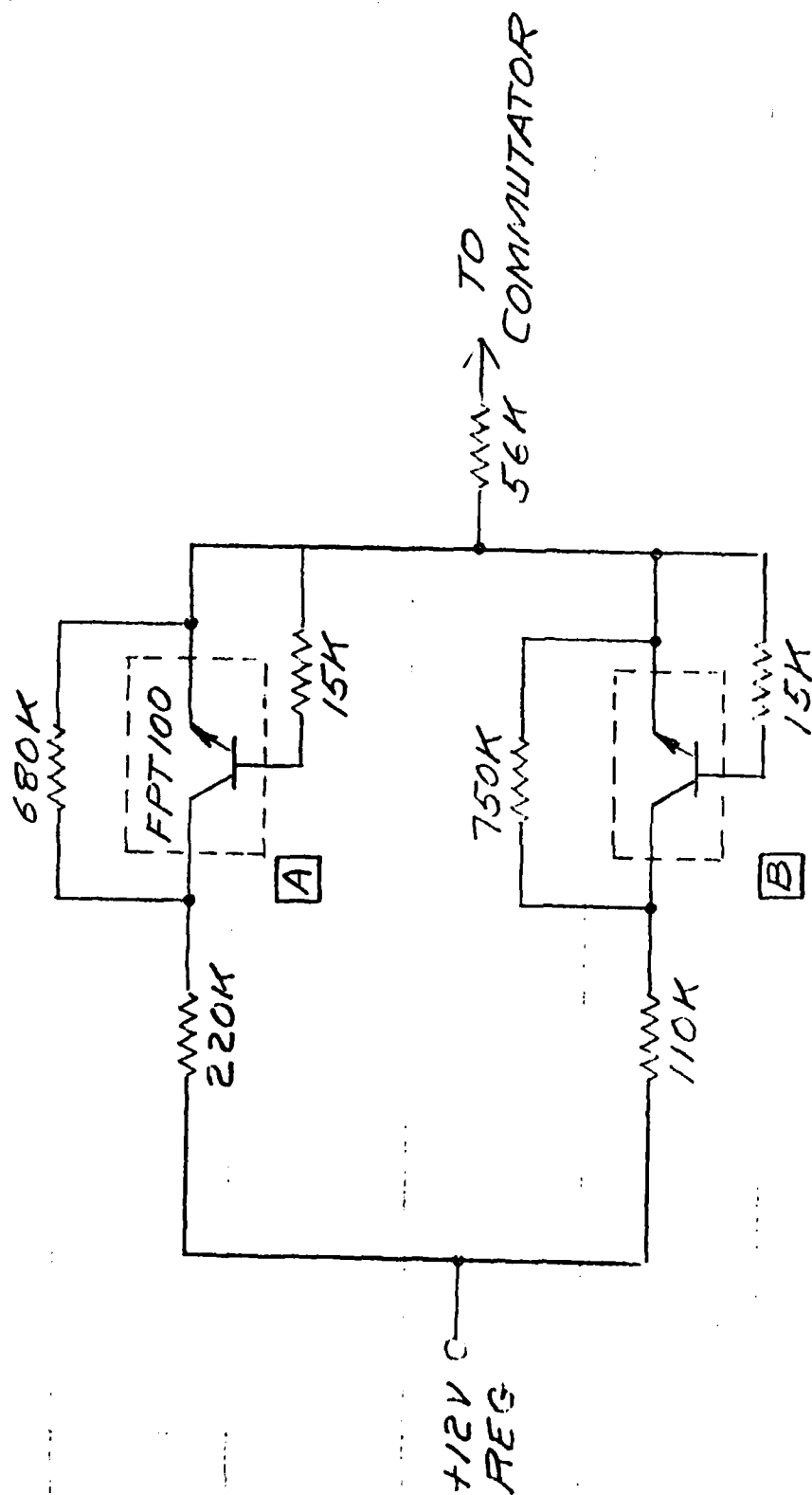


FIGURE 8B

RADIOSONDE OSCILLATOR CIRCUIT



3-18-81	TRI-CON ASSOC	
ENC.	SUN SENSOR	
C-201	A	2041

FIGURE 10

